CLAIMS

What is claimed is:

1. A method for monitoring the condition of a material, comprising:

determining a reference baseline for at least one characteristic of a material;

monitoring the at least one characteristic of the material across time and/or temperature;

comparing the monitored characteristic against the reference baseline; and

initiating a signal when the difference between the monitored characteristic and the reference baseline exceeds a predetermined value.

2. The method according to claim 1, wherein the material is formed into a heating element.

3. The method according to claim 1, wherein the reference baseline is a geometric model of the condition of the material.

4. The method according to claim 1, wherein the at least one characteristic is representative of the condition of the material.

5. The method according to claim 1, wherein the characteristic is the electrical resistance of the material.

6. The method according to claim 1, wherein the characteristic is a voltage value.

7. The method according to claim 1, wherein the characteristic is a current value.

8. The method according to claim 1, wherein the characteristic is a temperature value.

9. The method according to claim 1, wherein monitoring is performed over a predetermined temperature range.

10. The method according to claim 9, wherein monitoring is performed over a temperature range of 20° C to 1400° C.

11. The method according to claim 1, wherein monitoring is performed without shutting down the chamber in which the material is located.

12. The method according to claim 1, wherein monitoring the characteristic of the material is performed by measuring the electrical resistance of the material.

13. The method according to claim 1, wherein the difference between the monitored characteristic and the reference baseline is caused by elongation of the material.

14. The method according to claim 1, wherein the difference between the monitored characteristic and the reference baseline is caused by a metallurgical change in the composition of the material.

15. The method according to claim 1, wherein the difference between the monitored characteristic and the reference baseline is caused by a reduction in the cross-sectional area of the material.

16. The method according to claim 1, wherein at least two characteristics are monitored and wherein the difference between the monitored two or more characteristics and the reference baseline is caused by one or more of elongation of the material, a

metallurgical change in the composition of the material, and a reduction in the cross-sectional area of the material.

17. The method according to claim 16, wherein the difference is caused by changes in the two or more characteristics and wherein the degree of change in any characteristic is not equal to the degree of change in one or more of the other monitored characteristics.

18. The method according to claim 1, wherein the material is a wire heating element comprised of an alloy of approximately 72.2% iron, 22.0% chromium, and 5.8% aluminum.

19. The method according to claim 18, wherein the predetermined difference value is indicative of a metallurgical change in the material, comprising a change in the aluminum content to less than 3.0% of the alloy.

20. The method according to claim 1, wherein the baseline reference and the monitored characteristic are converted to a graphical representation, and wherein the comparison between the monitored characteristic and the reference baseline is a geometric comparison.

21. The method according to claim 1, wherein the signal is initiated when the difference reaches a predetermined value.

22. The method according to claim 1, wherein the initiated signal is sent to a decision making authority.

23. The method according to claim 1, including detecting degradation or failure of the material based on a sudden change in the monitored characteristic.

24. A method for monitoring the condition of a heating element, comprising:

determining a first graphical representation of a characteristic of a heating element as a reference baseline;

setting a threshold level of graphical change for the characteristic;

collecting data reflecting the condition of the characteristic of the heating element material after an interval;

converting the collected data to a second graphical representation;

comparing the difference between the first and second graphical representations against the threshold level of graphical change; and

sending a signal to a decision making authority when the difference reaches or exceeds the threshold level.

25. The method according to claim 24, wherein the heating element has an initial alloy composition of approximately 72.2% iron, 22.0% chromium, and 5.8% aluminum.

26. The method according to claim 24, wherein the threshold level is set such that a signal is sent to the decision making authority when the alloy reaches a composition having approximately 2.5% of aluminum.

27. The method according to claim 24, wherein the collected data comprises the resistance measurements of the heating element.

28. The method according to claim 24, wherein comparing is performed as a geometric comparison.

29. An apparatus for monitoring the condition of the material, comprising:

means for determining an initial composition of a material as a reference baseline at an initial time;

means for collecting data reflecting a subsequent composition of the material after a specified time interval;

means for setting a threshold level of change in the subsequent composition from the initial composition;

means for monitoring a change in the composition of the material after the interval has passed; and

means for sending a signal to a decision making authority when the monitored change has reached or exceeded the threshold level.

30. The apparatus according to claim 29, wherein the means for setting the initial composition sets a resistance baseline for a material comprising approximately 72.2% iron, 22.0% chromium and 5.8% aluminum.

31. The apparatus according to claim 29, wherein the threshold level comprises a level corresponding to the composition of the material containing approximately 2.5 % of aluminum.

32. The apparatus according to claim 29, wherein the means for collecting data comprises a microcontroller.

33. The apparatus according to claim 29, wherein the means for collecting data comprises a sensing mechanism for sensing conditions of a heating element.

34. The apparatus according to claim 33, wherein the sensing mechanism senses electrical characteristics of a heating element.

35. The apparatus according to claim 29, wherein the means for setting sets a threshold level corresponding to a normalized resistance curve from 1.0 to 1.27 across a temperature range of approximately 20° C to 1400° C.

36. The apparatus according to claim 29, wherein the means for monitoring comprises a microcontroller.

37. The apparatus according to claim 29, further comprising a decision making authority for responding to the means for sending, once the threshold level has been reached or exceeded.

38. The apparatus according to claim 37, wherein the decision making authority comprises a microcontroller.